For example, two of the common industry standard methods for dimming control of lighting systems are 0-10V dimmers and the Digital Array Lighting Interface (DALI), both of which provide digital control of the power output of lighting systems. Both of these methods are effective, but require the provision of control wiring separate from the conventional AC power lines. The addition of 0-10V dimmers or DALI to a lighting installation thus generally requires the retrofitting of any proposed installation site with the necessary control wiring, which typically requires ripping out existing wiring and the addition of new control wiring. The addition of convention dimming controls, such as 0-10V dimmers or DALI to a lighting installation thereby often imposes significant additional costs as well as additional time to accomplish the installation of the control wiring and controls.

[0005] There are existing dimming technologies used for traditional lighting sources which do not require extra communication wires. While there are many, two of the most popular are TRIAC (triode for alternating current) dimmer and Electronic Low Voltage (ELV) dimming. Both "phase chop" the AC signal, making less AC power available for the traditional light sources, hence causing the traditional light sources to provide less light output. These dimming technologies have been adapted to solid state lighting fixtures, however, since they are analog in nature, they are not an ideal solution due to the strictly digital nature of LEDs. There are two distinct disadvantages to incorporating TRIAC or ELV on the LED fixture. For example, there is an added cost associated with adding analog circuitry in order to transmit TRIAC or ELV dimming signals over a power line and to convert the analog signals to digital signals suitable for controlling LED fixtures. In addition, the addition of such specific purpose circuitry commits the LED fixture manufacturer to one technology, thus limiting the ability of the manufacturer to adapt to other dimming technologies that may be required in different applications and installations.

[0006] The present invention provides a solution to the above noted as well as other related problems associated with the prior art.

SUMMARY

[0007] ~~Emobidments~~Embodiments of the present invention are directed to a powerline communication control system for controlling a light emitting diode (LED) lighting unit comprised of one or more white or red, green and blue LEDs, or combinations thereof, and the associated circuitry for controlling the light outputs of the LEDs of the fixture.

[0007a] According to a first aspect of the present invention, there is provided ~~a powerline communication control system for controlling a lighting fixture, comprising a master controller, further comprising a conventional dimmer interface configured to interconnect~~

~~with a plurality of different conventional dimmer controllers; a lighting control processor in communication with the dimmer interface, the lighting control processor generates a lighting unit command output in a lighting unit system command format in response to an indication of a user-adjusted setting of any interconnected plurality of different conventional dimmer controllers received from the conventional dimmer interface; and a power distribution system interface in communication with the lighting control processor and configured to interconnect with a power distribution system, the power distribution system interface superimposes the lighting unit system command output onto the power distribution system when connected thereto; and a plurality of lighting fixture controllers, each controller comprising a command receiving interface configured to interconnect with the power distribution system, the command receiving interface separates the lighting unit system command output from the power distribution system when connected thereto; a slave control processor in communication with the command receiving interface and converts the received lighting unit system command output into a corresponding lighting unit control command; and a lighting unit interface for providing the lighting unit control command to its respective lighting unit to control the respective lighting unit in response to the user-adjusted setting of any one of the interconnected conventional dimmers.~~ a system for controlling a light emitting diode (LED) lighting unit via the LED lighting unit's power distribution system, the system comprising: a power distribution system for supplying operational power to the LED lighting unit; at least one conventional dimmer for supplying a user-adjusted setting to the LED lighting unit; at least one master controller coupled to the power distribution system and the at least one conventional dimmer, the master controller including: a lighting control command processor configured to receive a lighting unit control input from the at least one conventional dimmer and configured to generate corresponding lighting unit command outputs in a lighting system command format in response to an indication of the user-adjusted setting of the conventional dimmer; and a power distribution system interface configured to superimpose the lighting unit command outputs onto the power distribution system and a power signal present thereon as a lighting command signal according to a lighting unit command transmission mode, and at least one device controller coupled to the at least one master controller, each device controller including: a command receiving interface configured to receive the lighting command signal, separate the lighting command signal from the power signal, and generate corresponding lighting control commands, a lighting control processor configured to covert the received lighting control commands into lighting unit control commands; and a lighting unit interface configured to provide the lighting unit control commands to the at least one lighting unit to control the at least one lighting unit in response

to the user-adjusted setting of the conventional dimmer; and at least one LED lighting unit coupled to the at least one device controller.

[0007b] ~~According to a second aspect of the present invention, there~~ There is ~~provided~~disclosed a method for controlling a lighting fixture, comprising generating a lighting unit command output in a lighting unit system command format in response to a determined user-adjusted setting of any interconnected plurality of different conventional dimmer controllers received from a conventional dimmer interface; distributing through a power distribution system the lighting unit command output to a plurality of lighting fixtures; converting at each respective lighting fixture the lighting unit command output into a corresponding lighting unit control command; and controlling each respective lighting unit in response to the user-adjusted setting of any one of the interconnected conventional dimmers.The system further includes at least one lighting slave unit including at least one LED lighting unit, a command receiving interface connected from the power distribution system for receiving the lighting command signal, separating the lighting command signal from the power signal and generating corresponding slave control commands, a slave control processor for converting the received slave control commands into lighting unit control commands, and a lighting unit interface for providing the lighting unit control commands to the at least one lighting unit to control the at least one lighting unit.

[0007c] ~~According to a third aspect of the present invention, there~~ There is ~~provided~~disclosed a powerline communication control system for controlling a light emitting diode (LED) lighting unit, the powerline communication control system comprising at least one master controller including a lighting control processor configured to receive a lighting unit control input from a plurality of different conventional dimmer lighting controllers and configured to generate corresponding lighting unit command outputs in a lighting system command format in response to an indication of a user-adjusted setting of any of the interconnected plurality of different conventional dimmer lighting controllers received from a conventional dimmer interface of a conventional dimmer; and a power distribution system interface coupled to the lighting control processor and connected to a power distribution system configured to superimpose the lighting unit command outputs onto the power distribution system and a power signal present thereon as a lighting command signal according to a lighting unit command transmission mode, and a plurality of lighting slave units, each slave unit including at least one LED lighting unit, a command receiving interface connected to the power distribution system configured to receive the lighting command signal, separate the lighting command signal from the power signal, and generate corresponding slave control commands, a slave control processor configured to convert the

received slave control commands into lighting unit control commands, and a lighting unit interface configured to provide the lighting unit control commands to the at least one LED lighting unit to control the at least one LED lighting unit in response to a user-adjusted setting of any one of the interconnected conventional dimmers.

[0007d] ~~According to a fourth aspect of the present invention, there~~ There is ~~provided~~disclosed a system for controlling a light emitting diode (LED) lighting unit via the LED lighting unit's power distribution system, the system comprising a power distribution system for supplying operational power to the LED lighting unit; at least one conventional LED dimmer for supplying a user-adjusted setting to the LED lighting unit; at least one master controller coupled to the power distribution system and the at least one conventional LED dimmer, the master controller including a lighting control command processor configured to receive a lighting unit control input from the at least one conventional LED dimmer and configured to generate corresponding lighting unit command outputs in a lighting system command format in response to an indication of the user-adjusted setting of the conventional LED dimmer; and a power distribution system interface configured to superimpose the lighting unit command outputs onto the power distribution system and a power signal present thereon as a lighting command signal according to a lighting unit command transmission mode, and at least one device controller coupled to the at least one master controller, each device controller including a command receiving interface configured to receive the lighting command signal, separate the lighting command signal from the power signal, and generate corresponding lighting control commands, a lighting control processor configured to covert the received lighting control commands into lighting unit control commands; and a lighting unit interface configured to provide the lighting unit control commands to the at least one lighting unit to control the at least one lighting unit in response to the user-adjusted setting of the conventional LED dimmer; and at least one LED lighting unit coupled to the at least one device controller.

[0008] A powerline communication control system as disclosed herein includes a master controller that includes a lighting control command processor for receiving a lighting

CLAIMS

1. A powerline communication control system for controlling a lighting fixture, comprising:

a master controller, comprising:

a conventional dimmer interface configured to interconnect with a plurality of different conventional dimmer controllers;

a lighting control processor in communication with the dimmer interface, the lighting control processor generates a lighting unit command output in a lighting unit system command format in response to an indication of a user-adjusted setting of any interconnected plurality of different conventional dimmer controllers received from the conventional dimmer interface; and

a power distribution system interface in communication with the lighting control processor and configured to interconnect with a power distribution system, the power distribution system interface superimposes the lighting unit system command output onto the power distribution system when connected thereto; and

a plurality of lighting fixture controllers, each controller comprising:

a command receiving interface configured to interconnect with the power distribution system, the command receiving interface separates the lighting unit system command output from the power distribution system when connected thereto;

a slave control processor in communication with the command receiving interface and converts the received lighting unit system command output into a corresponding lighting unit control command; and

a lighting unit interface for providing the lighting unit control command to its respective lighting unit to control the respective lighting unit in response to the user-adjusted setting of any one of the interconnected conventional dimmers.

2. The powerline communication control system of claim 1, wherein each dimmer controller of the plurality of different conventional dimmer controllers is selected from the group consisting of: digital multiplex (DMX) dimmer controllers; 0-10 volt dimmer

controllers; TRIAC dimmer controllers; electronic low voltage (ELV) dimmer controllers; and current loop controllers, such as 4-20 mA control loop controllers.

3. The powerline communication control system of claim 1, wherein the power distribution system is selected from the group consisting of: an AC line; a 117 volt AC line; a 230 volt AC line; a 100 volt AC line; a 277 volt AC line; a 347 volt AC line; a DC line; a 380 volt DC line; a 48 volt DC line; a 24 volt DC line; a 12 volt DC line; and combinations thereof.

4. The powerline communication control system of claim 1, wherein the power distribution system interface comprises a modulator adapted to superimpose the lighting unit system command output an AC power signal of the power distribution system.

5. The powerline communication control system of claim 4, wherein the modulator modulates the AC power signal according to a modulation selected from the group consisting of: amplitude modulation; frequency modulation; phase modulation; binary phase shift keying modulation; quadrature phase shift keying modulation; quadrature amplitude modulation; frequency shift keying modulation; phase shift keying modulation; and combinations thereof.

6. The powerline communication control system of claim 1, wherein the at least one lighting unit comprises at least one lighting element and a lighting element driver.

7. The powerline communication control system of claim 6, wherein the at least one lamp is a light emitting diode (LED).

8. A method for controlling a lighting fixture, comprising:

generating a lighting unit command output in a lighting unit system command format in response to a determined user-adjusted setting of any interconnected plurality of different conventional dimmer controllers received from a conventional dimmer interface;

distributing through a power distribution system the lighting unit command output to a plurality of lighting fixtures;

converting at each respective lighting fixture the lighting unit command output into a corresponding lighting unit control command; and

controlling each respective lighting unit in response to the user-adjusted setting of any one of the interconnected conventional dimmers.

9. The method of claim 8, wherein distributing through a power distribution system the lighting unit command output to at least one lighting fixture, comprises:

superimposing the lighting unit system command output onto the power distribution system;

receiving from the power distribution system distributed power with the superimposed lighting unit system command output; and

separating the lighting unit system command from the distributed power.

10. The method of claim 8, further comprising, detecting an electrical response of any of the interconnected plurality of different conventional dimmer controllers received from a conventional dimmer interface, the electrical response variable according to the user-adjusted setting.

11. The method of claim 10, further comprising:

isolating any of interconnected plurality of different conventional dimmer controllers from the power distribution system; and

electrically stimulating any of interconnected plurality of different conventional dimmer controllers, thereby inducing the electrical response.

12. A powerline communication control system for controlling a light emitting diode (LED) lighting unit, the powerline communication control system comprising:

at least one master controller including:

a lighting control processor configured to receive a lighting unit control input from a plurality of different conventional dimmer lighting controllers and configured to generate corresponding lighting unit command outputs in a lighting system command format in response to an indication of a user-adjusted setting of any of the interconnected plurality of different conventional dimmer lighting controllers received from a conventional dimmer interface of a conventional dimmer; and

a power distribution system interface coupled to the lighting control processor and connected to a power distribution system configured to superimpose the lighting

unit command outputs onto the power distribution system and a power signal present thereon as a lighting command signal according to a lighting unit command transmission mode, and a plurality of lighting slave units, each slave unit including:

at least one LED lighting unit,

a command receiving interface connected to the power distribution system configured to receive the lighting command signal, separate the lighting command signal from the power signal, and generate corresponding slave control commands,

a slave control processor configured to convert the received slave control commands into lighting unit control commands, and

a lighting unit interface configured to provide the lighting unit control commands to the at least one LED lighting unit to control the at least one LED lighting unit in response to a user-adjusted setting of any one of the interconnected conventional dimmers.

13. The powerline communication control system for controlling a light emitting diode (LED) lighting unit according to claim 12, wherein each master controller includes:
for each conventional dimmer lighting controller of any of the interconnected plurality of different conventional dimmer lighting controllers, a corresponding lighting control conversion circuit for converting control inputs from a corresponding conventional dimmer lighting controller into corresponding command inputs to the microprocessor.

14. The powerline communication control system for controlling a light emitting diode (LED) lighting unit according to claim 12, wherein each master controller includes:
a lighting controller, and

a lighting control conversion circuit for converting control inputs from the lighting controller into the command inputs to the microprocessor.

15. The powerline communication control system for controlling a light emitting diode (LED) lighting unit according to claim 12, wherein the power distribution system is selected from the group consisting of an AC line; a 117 volt AC line; a 230 volt AC line; a 100 volt AC line; a 277 volt AC line; a 347 volt AC line; a DC line; a 380 volt DC line; a 48 volt DC line; a 24 volt DC line; a 12 volt DC line; and combinations thereof.

16. The powerline communication control system for controlling a light emitting diode (LED) lighting unit according to claim 12, wherein the at least one conventional dimmer controller is selected from the group consisting of: digital multiplex (DMX) dimmer controllers; 0-10 volt dimmer controllers; TRIAC dimmer controllers; electronic low voltage (ELV) dimmer controllers; and current loop controllers.

17. A system for controlling a light emitting diode (LED) lighting unit via the LED lighting unit's power distribution system, the system comprising:

a power distribution system for supplying operational power to the LED lighting unit;

at least one conventional LED dimmer for supplying a user-adjusted setting to the LED lighting unit;

at least one master controller coupled to the power distribution system and the at least one conventional LED dimmer, the master controller including:

a lighting control command processor configured to receive a lighting unit control input from the at least one conventional LED dimmer and configured to generate corresponding lighting unit command outputs in a lighting system command format in response to an indication of the user-adjusted setting of the conventional LED dimmer; and

a power distribution system interface configured to superimpose the lighting unit command outputs onto the power distribution system and a power signal present thereon as a lighting command signal according to a lighting unit command transmission mode, and

at least one device controller coupled to the at least one master controller, each device controller including:

a command receiving interface configured to receive the lighting command signal, separate the lighting command signal from the power signal, and generate corresponding lighting control commands,

a lighting control processor configured to covert the received lighting control commands into lighting unit control commands; and

a lighting unit interface configured to provide the lighting unit control commands to the at least one lighting unit to control the at least one lighting unit in response to the user-adjusted setting of the conventional LED dimmer; and

at least one LED lighting unit coupled to the at least one device controller.

18. The system of Claim 17, wherein each master controller further comprising:

for each conventional dimmer lighting controller, a corresponding lighting control conversion circuit for converting control inputs from a corresponding conventional dimmer lighting controller into corresponding command inputs to the lighting control processor.

19. The system of Claim 17, wherein the master controller further comprising:

a lighting controller, and

a lighting control conversion circuit for converting control inputs from the lighting controller into the command inputs to the lighting control processor.

20. The system of Claim 17, wherein the power distribution system is selected from the group consisting of an AC line; a 117 volt AC line; a 230 volt AC line; a 100 volt AC line; a 277 volt AC line; a 347 volt AC line; a DC line; a 380 volt DC line; a 48 volt DC line; a 24 volt DC line; a 12 volt DC line; and combinations thereof.

21. The system of Claim 17, wherein a plurality of conventional dimmer controllers are coupled to a respective master controller for supplying a respective conventional LED dimmer control input thereto.

22. The system of Claim 21, wherein the at least one conventional dimmer controller is selected from the group consisting of: digital multiplex (DMX) dimmer controllers; 0-10 volt dimmer controllers; TRIAC dimmer controllers; electronic low voltage (ELV) dimmer controllers; and current loop controllers.

CLAIMS

1. A system for controlling a light emitting diode (LED) lighting unit via the LED lighting unit's power distribution system, the system comprising:

a power distribution system for supplying operational power to the LED lighting unit;

at least one conventional dimmer for supplying a user-adjusted setting to the LED lighting unit;

at least one master controller coupled to the power distribution system and the at least one conventional dimmer, the master controller including:

a lighting control command processor configured to receive a lighting unit control input from the at least one conventional dimmer and configured to generate corresponding lighting unit command outputs in a lighting system command format in response to an indication of the user-adjusted setting of the conventional dimmer; and

a power distribution system interface configured to superimpose the lighting unit command outputs onto the power distribution system and a power signal present thereon as a lighting command signal according to a lighting unit command transmission mode, and

at least one device controller coupled to the at least one master controller, each device controller including:

a command receiving interface configured to receive the lighting command signal, separate the lighting command signal from the power signal, and generate corresponding lighting control commands,

a lighting control processor configured to covert the received lighting control commands into lighting unit control commands; and

a lighting unit interface configured to provide the lighting unit control commands to the at least one lighting unit to control the at least one lighting unit in response to the user-adjusted setting of the conventional dimmer; and

at least one LED lighting unit coupled to the at least one device controller.

2. The system of claim 1, wherein each master controller further comprising:

for each conventional dimmer, a corresponding lighting control conversion circuit for converting control inputs from a corresponding conventional dimmer into corresponding command inputs to the lighting command control processor.

3. The system of claim 1, wherein the master controller further comprising:

a lighting controller, and

a lighting control conversion circuit for converting control inputs from the lighting controller into the command inputs to the lighting command control processor.

4. The system of claim 1, wherein the power distribution system is selected from the group consisting of an AC line; a 117 volt AC line; a 230 volt AC line; a 100 volt AC line; a 277 volt AC line; a 347 volt AC line; a DC line; a 380 volt DC line; a 48 volt DC line; a 24 volt DC line; a 12 volt DC line; and combinations thereof.

5. The system of claim 1, wherein a plurality of conventional dimmers are coupled to a respective master controller for supplying a respective conventional LED dimmer control input thereto.

6. The system of claim 5, wherein the at least one conventional dimmer is selected from the group consisting of: digital multiplex (DMX) dimmer controllers; 0-10 volt dimmer controllers; TRIAC dimmer controllers; electronic low voltage (ELV) dimmer controllers; and current loop controllers.